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LABOUR PRODUCTIVITY FOR PRE-COMMERCIAL SELECTION THINNING IN YOUNG CONIFEROUS STANDS IN MANITOBA

Canada

Manitoba

LABOR PRODUCTIVITY FOR PRE-COMMERCIAL SELECTION THINNING IN YOUNG CONIFEROUS STANDS IN MANITOBA

A File Report

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ABSTRACT

Labor productivity for pre-commercial selection thinning in young coniferous stands was examined at five locations in Manitoba during 1985. Sixty-three sample plots were established to measure pre-treatment stand characteristics and labor times required to manually thin to 2 m spacing. Preliminary results show wide variation in both stand characteristics and thinning times. Additional data must be collected before productivity trends can be developed.

This report describes field methods used in the study and provides general data summaries.

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INTRODUCTION

Overdense naturally regenerated coniferous stands are common after wildfire or even occasionally after logging. Reducing stand density in such stands by removal of surplus stems can improve the growth rate of residual trees as well as provide other benefits, depending on the objectives of the forest manager. When surplus stems are not utilized, the treatment is commonly known as pre-commercial thinning. Benefits of pre-commercial thinning, regardless of the objectives however are realized at a cost - the cost of doing the thinning.

As pre-commercial thinning programs are anticipated or existing programs expanded, there is a growing need to know the costs associated with such treatments. More specifically, there is a need to know how costs reflect the variability of those stand conditions which are determinants of project costs. Although historical records can provide some indication of thinning costs, they are in general, only useful when aggregated since little supporting documentation on the various cost components or work conditions is available. Consequently, such data are applicable only for average forest and job conditions and may add little to the precision of the manager's best guess when predicting costs to treat a specific stand. In addition, historical cost information may quickly become outdated because of changing prices or may not be applicable to a particular geographical region because of differing wage scales. Therefore not only cost data is needed but also information on labor and/or machine productivity for individual sites. Productivity is generally not affected by geographical location for comparable stand conditions and is constant over time.

This study was initiated during the summer of 1985 to determine pre-commercial thinning costs in Manitoba. Specifically, the purpose of this study is to describe empirically the relationship between site conditions (stand density, tree size, and ground conditons) and labor inputs (person-hours) required to pre-commercially thin juvenile coniferous stands on an operational scale. Knowledge of labor inputs required under various stand conditions will:

(1) Assist managers planning silviculture programs and provide guidelines for the efficient allocation of resources to various silvicultural treatments;
(2) Provide guidelines for managers when assessing contract bids for thinning work or determining pay rates for specific thinning projects;
(3) Assist private contractors in preparing realistic bids;
(4) Provide data for economic analysis of thinning individual stands, particularly in a cost-benefit framework;
(5) Improve the ability to predict employment impacts when thinning

work is undertaken as a job creation scheme.

This study is part of Project C/M-7.2 entitled Economics of Intensive Forest Management and is funded by the Canada-Manitoba Forest Renewal Agreement. The purpose of Project C/M-7.2 is to develop economic guidelines, through determination of labor and/or machine productivity and costs, for a variety of silvicultural treatments to ensure cost effective use of intensive forest management funds.

This file report summarizes work completed to date in developing productivity estimates for one silviculture treatment - pre-commercial thinning. Study methods used to determine labor inputs are outlined and data summaries are presented from five pre-commercial thinning projects undertaken in Manitoba during 1985. In the preliminary stages of this study, only labor and machine times required to create a prescribed treatment are examined; later stages will address costs associated with the various treatments.

BACKGROUND

Substantial areas of juvenile conifers are currently being thinned by both private firms and government agencies. Recent federal-provincial forestry agreements have led to increased activity in many areas of forest management including pre-commercial thinning. Thinning programs will likely expand in an attempt to enhance future timber supplies. The majority of these thinning operations will follow selective thinning techniques which are inherently labor intensive and require substantial expenditures. Therefore it is essential that forest managers know the costs of such operations, particularly on a site specific basis.

Several studies in Canada have examined labor productivity for manual thinning. Britt and Galimore (1983) conducted time studies for operational thinning with chain saws in British Columbia. They found average labor productivity rates of 11 hours per ha at interior sites and 19 hours per ha at coastal sites. Their results however may not be applicable to stand conditions and operational methods used in Manitoba. Hedin (1982) and Riley (1973) provided labor productivity for pre-commercial thinning young conifers using different hand and power tools. Their studies provided averages applicable to entire operations and may not be suitable to estimate costs to treat a particular stand. For example Hedin reported thinning times ranging from 7.5 to 25 hours per ha using chainsaws in 20- to 30-year-old Douglas fir and hemlock stands where pre-treatment density was less than 6,000 stems per ha. (A list of botanical names is provided in Appendix 1.) She also reported thinning times of 17.5 hours per ha in 3- to 10-year-old lodgepole pine stands (density 6,800) thinned with manual

shears and 21.2 hours for brushsaw thinning in 10- to 15-year-old lodgepole pine stands (density 20,300 stems per ha). Riley's data indicate productivity times for thinning jack pine ranged from 9.7 hours per ha in 9-year-old stands (density 13,170 stems per ha) thinned with brushsaws to 68.2 hours per ha in 33-year-old stands (density 5,560 stems per ha) thinned with hand tools (predominantly sandvik axe). Bella (1974) also presented thinning rates using brushsaws in young lodgepole pine stands in Alberta. His productivity estimates for 16-year-old stands range from 5.2 hours per ha at pre-treatment stand density of 13,800 stems to 19 hours at 82,300 stems. The same study showed thinning rates of 20 to 22 hours per ha in 33-year-old stands where density ranged from 45 to 48,000 stems per ha. His study was based on one cutter's performance within the limits of an experimental setting.

This study examines labor productivity for thinning in terms of several stand variables viz. density, tree size and ground conditions. Data for this study are from operational thinning projects in Manitoba and are based on the performance of several experienced cutters from each operation.

STUDY AREA DESCRIPTIONS

Stands included in the study were thinned on an operational scale. Thinning was selective and in general favoured healthy dominant conifers while striving for 2 m spacing. The areas included in this report were sampled during the summer, fall, and early winter of 1985. General locations of study areas are shown in Figure 1. Stand statistics before thinning are summarized in Table 1 by area and are presented in more detail in Appendix 2. A description of each area sampled follows. Tree size and density statistics presented in area descriptions refer to trees with diameter at breast height (dbh) of 1 cm or greater.

Area 1: Dragline Lake, Duck Mountain Provincial Forest.

The area was located in the Duck Mountain Provincial Forest near Dragline Lake in Township 21, Range 25, WPM. The stands originated after a wild fire in 1962. Local topography was flat to gently rolling and soils were a sandy clay with some exposed rocks. Portions of the burned area were salvage logged and few standing snags remained. By 1985, deadfalls still prevailed although in general, slash conditions were light. Jack pine was the predominant species however trembling aspen was frequently mixed with the pine. Local dense patches of alder and willow were common. Age of the pine at time of thinning was 22 years.

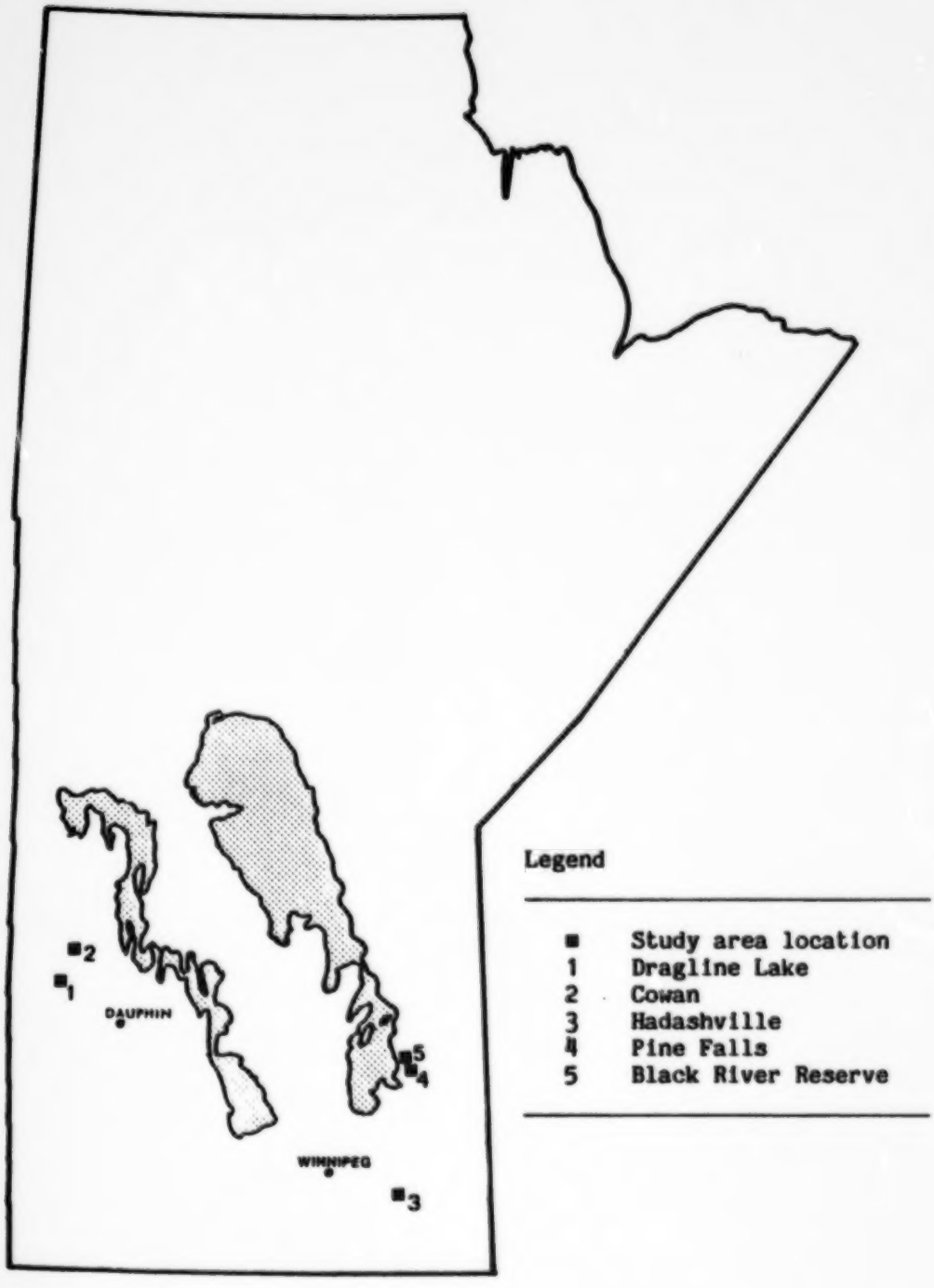

FIGURE 1. General locations of study areas of precommercial thinning in Manitoba, 1985.

TABLE 1. Stand summaries before thinning.

Attribute		Dragline Lake	Cowan	Hadashville	Pine Falls	Black River Reserve
Stand age		22	22	31	20	17
Stems > 1 cm dbh						
Living conifers	Stems/ha	10,720	12,882	11,799	8,016	9,153
	Avg dbh (cm)	4.7	4.2	6.4	3.6	2.8
	Avg height (m)	5.6	5.5	8.6	4.0	3.3
Living hardwoods	Stems/ha	2,277	2,553	2,029	1,185	3,897
	Avg dbh (cm)	1.7	1.3	1.0	1.5	1.4
Dead standing (all species)	Stems/ha	54	13,379	9,868	253	871
	Avg dbh (cm)	12.6	1.8	2.0	1.4	1.4
Total	Stems/ha	13,051	28,814	23,696	9,454	13,921
	Avg dbh (cm)	4.2	2.8	4.1	3.3	2.3
All species: dbh < 1cm or height < 1.3 m						
Living	Stems/ha	17	6,266	4,907	3,320	5,193
Dead standing	Stems/ha	0	925	630	925	1,026
Total	Stems/ha	17	7,191	5,537	4,245	6,219
Total: all standing stems						
	Stems/ha	13,068	36,005	29,233	13,699	20,140

Based on 17 sample plots used to determine thinning times, average height and dbh of the jack pine was 5.6 m and 5 cm respectively with densities averaging 10,719 trees per ha and ranging up to 15,491. Hardwood densities averaged 2,278 and ranged up to 34,443 stems per ha.

Area 2: Cowan, Mountain Forest Section.

The area was located in Township 36, Range 22, WPM near the town of Cowan. The stands originating after a fire in 1962 were almost pure 22-year-old jack pine. A dense black spruce understory commonly occurred in dense patches throughout the sampled areas. There was no evidence of post-fire salvage logging although few standing snags were observed. Slash from the fire ranged from nil to extremely heavy. Topography was flat and soils sandy. The jack pine averaged 5.5 m in height and 4 cm in dbh with densities ranging up to 15,733 trees per ha and averaging 12,881. The spruce understory was less than 1 m in height. Hardwood densities averaged 2,553 and ranged up to 11,000.

Area 3: Hadashville, Sandilands Provincial Forest.

The stand was located in the Sandilands Provincial Forest in Township 6, Range 11, EPM. The fire origin stand contained almost pure 31-year-old jack pine with scattered individuals of black spruce. Topography was flat and soils were a fine sand. In 1964, at stand age 9 years, the area was mechanically strip thinned with a drum chopper. That treatment created cleared corridors about 2.5 m wide alternating with uncut strips about 3 m in width. In 1985 slash from the fire and from the 1964 treatment was virtually non-existant. Sample plot measurements indicated jack pine averaged 8.6 m in height and 6 cm in dbh. Stand density, based on the area of residual strips averaged 11,799 living jack pine per ha and ranged up to 20,800.

Area 4: Pine Falls, Lake Winnipeg East Forest Section.

The area was located approximately 23 km north of the Powerview Dam along highway 304 in Township 20, Range 10 EPM. The stands were naturally regenerated after logging in 1965. Slash from the previous logging operation was minimal although a 25 to 40 cm deep snow cover obscured slash determination. Black spruce was the dominant species and was favoured by the thinning however substantial amounts of tamarack occurred throughout the site. Densities for both conifers combined averaged 8,015 trees per ha and ranged up to 11,143. Average height and diameter of these conifers was 4.0 m and 4 cm respectively. The hardwood component ranged up to 2,133 stem per ha.

Area 5. Black River Reserve.

The area was located north of Pine Falls along the Black River Reserve Road in Township 21, Range 9 EPM. The stands originated after logging in 1965 and were comprised mainly of black spruce, tamarck and balsam fir. Average age of the black spruce regeneration was 17 years although older previously suppressed spruce and fir were also present. Topography was flat and the site was poorly drained. At the time of the thinning operation (late November) there was a 40 cm snow cover on the ground and soils were frozen. Slash from the 1965 logging operation was not evident. The area was thinned to release black spruce from competing conifers (tamarck and balsam fir) and hardwoods (white birch and alder). Average height and dbh of the conifers was 3.3 m and 3 cm respectively, with densities averaging 9,153 stems per ha and ranging up to 12,444. The hardwood component averaged 3,897 and ranged up to 8,333 stems per ha.

THE THINNING WORK

The thinning work was carried out by both private contractors where cutters were paid on a piece-work basis, and by hourly paid workers employed by the provincial government. As well as felling trees, cutters were to ensure that cut trees be left lying close to the ground to reduce the fire hazard created by the thinning slash.

In areas 1 and 2, thinning was carried out using Husqvarna 165R motorized brushsaws. Cutters were paid on a piece-work basis and worked independent of each other. Their instructions were to thin to 2 m spacing leaving only healthy jack pine trees.

In area 3, thinning was done with small chain saws by hourly paid provincial employees. Cutters worked in two-person crews, one operated the saw while the other selected trees to be cut and directed felled trees into stand openings. The second person also carried an axe and would occassionally fell smaller trees or assist in clearing standing dead trees. Felled trees were sometimes partially limbed and bucked by the saw operator to reduce the fire hazard. Thinning within residual strips was to 2 m spacing. Particular attention was paid to the condition of residual trees (i.e., only trees with good stem form and no evidence of insect or disease damage were retained).

In areas 4 and 5, thinning was done with both chain saws and brush saws. Cutters in these areas were paid on a piece-work basis and worked independently although close to each other. The thinning work generally followed the same procedures as in areas 1 and 2. At the time areas 4 and

5 were sampled, the cold temperatures and heavy snow cover on the ground and on the tree crowns may have affected the cutters' productivity. In addition, the deep snow caused the cutters to leave live whorls on some stumps or miss smaller trees altogether. This may reduce the effectiveness of the treatment.

STUDY METHODS

Sample Plot Selection and Layout

During sample plot layout and subsequent measurements, every effort was made to avoid any disruption to the thinning crew. There was no attempt by the research team to direct cutters to thin specific areas. The cutters' work and stand characteristics were measured wherever the cutter was working during the particular day of field sampling with the result that the full range of stand conditions may not have been covered. Productivity data therefore apply only to stand conditions encompassed by the sample plots and may not be representative of the whole thinning operation at a particular study area.

Sample plots were established in the unthinned portion of the stand a short distance ahead of a cutter so as not to interfere or influence his normal work pattern. In this way, bias on the part of the cutter to change his work habits during the time measurements could be reduced. No interaction between the cutter and the research team was required during plot layout and subsequent time measurements. Within a study area, several different cutters were sampled. Only experienced cutters - those that had been thinning for several weeks - were included in the study.

Plot dimensions were selected to accommodate the work pattern of individual cutters. Some cutters preferred to work in narrow strips thinning in a tight S pattern while some chose to work in wide swaths or in small circles or blocks. Consequently, plot dimensions varied so that the cutter could thin the plot area in one pass using his normal work method. The cutter however was not restricted to staying within plot boundaries. Stop watches used in the time measurements were started or stopped as the cutter entered or exited a plot so that time measurements would apply only to the plot area. Allowing the cutter to continue his work pattern regardless of whether he was thinning in a sample plot or not reduces bias arising from different plot size as well as improves the objectivity of time observations. In area 3, cutters were restricted to working within the 3 m wide unchopped strip, therefore long narrow plots were located ahead of the cutter within the residual strip.

Sample plots were made large enough to measure 5 to 10 minutes of

thinning work while striving to maintain uniform stand conditions. Table 2 summarizes number of plots and plot dimensions for each study area.

Plot and Time Measurements

Prior to thinning, dbh was measured for all standing stems greater than breast height and recorded by species category or as dead. Stems less than breast height were counted and recorded in their appropriate species category. Dead standing trees were included in the pre-treatment measurements because cutters were to fell these as well as living trees as part of the thinning operation. Under such circumstances, the number of dead standing trees influence labor productivity for thinning work although removal of dead trees may offer no biological advantage to the residual stand. Larger shrub species (willow, alder, hazel) were also included in the dbh measurements and were catagorized as "other hardwoods".

A sub-sample of trees covering the range of tree sizes were measured for total height, dbh, and diameter at stump height (about 10 cm above ground). This sub-sample was taken for every plot (10 to 12 trees per plot) or for groups of plots (15 to 20 trees per group) if plots were clustered. Data from the sub-samples were to provide estimates of average tree dimensions which may effect labor productivity. Measurements were taken on both standing and felled trees.

Ground or slash conditions for each plot prior to thinning were determined from samples taken at 2 m intervals along one plot diagonal. Piece diameter and height above ground was recorded for material occuring at each sample point. This slash measurement was taken to describe impediments to the cutter's movements. At the Pine Falls and Black River study areas, snow depths were determined in lieu of slash measurements.

Time measurements commenced when the cutter(s) entered the plot. The cutter proceeded to thin the plot following his normal work pattern. Stop watches used to measure thinning time were started or stopped as the cutter entered or exited the plot. During the thinning, a count was made of the number of cuts made by the cutter. When several small trees were cut in one swinging motion, this was counted as one cut. When a tree was cut several times along its stem, (as was often done to release hang-ups or to ensure the tree was left lying close to the ground) each cut was counted. The number of cuts were recorded to account for differing work styles among the cutters. Some cutters often made several cuts along the tree's stem to facilitate felling while others preferred to guide the trees by hand. If the cutter stepped out of the plot to work on trees which had been within plot boundaries before felling (eg. hang-ups) this time was considered as being within the plot.

During the plot thinning, a count was made of the cutter's activities

TABLE 2. Summary of sample plot sizes by study area.

Study area	Number of sample plots	Plot sizes (square metres)		
		Average	Minimum	Maximum
Dragline Lake	17	76.9	46.5	114.1
Cowan	12	74.5	49.0	100.0
Hadashville	21	51.6	36.2	70.0
Pine falls	5	106.0	45.0	225.0
Black River Reserve	3	92.5	87.5	100.0

as they occured at 20 second intervals. The following activity categories were recorded for the saw operator:

felling - cutting a tree at the stump
hang-ups - releasing a tree that was hung-up
brushing - removing shrubs less than 1.3 m in height
walking - walking from one tree to another
stopped - no activity

In area 3, where chain saws were used, separate times and activity counts were made for each member of the two-person crew. Activities included for the saw operator at area 3 were similar to the other areas except another category called "limbing" (which included bucking) was added. Number of cuts were not recorded for this area since the saw operator only cut a tree once and additional cuts made to the stem after it had been felled were included in the "limbing" category. Activities for the second crew member were also similar but with the following additions:

selecting - selecting trees to be felled
holding - assisting the saw operator by holding and guiding a cut tree into a opening
piling - positioning felled trees into piles along the open strip

These work activities were recorded for two reasons; (1) to account for different work styles among cutters which may in turn account for the variation in thinning times, and (2) to provide information on the distribution of work activities which might be related to stand conditions. The latter could also be useful in developing training programs for inexperienced workers or provide managers with an indication of how to improve worker productivity. Table 3 presents a summary of the distribution of workers' activities for each area.

After a plot was completely treated, dbh of all residual trees was measured. Photographs were taken for each plot before and after treatment.

RESULTS

Since the intent of this report is to provide information on data collection techniques and preliminary productivity summaries, no statistical analyses or productivity trends are presented. This section therefore merely highlights some of the findings from the study to date.

Labor productivity summaries by study area are presented in Table 4. Wide variation in production rates that occurred within an area are readily apparent. For example at Dragline Lake, productivity ranged from 9 to 34.6 hours per ha, however the number of stems cut at this area also showed a wide range - from about 5,000 to 34,000 stems per ha. At Cowan, productivity ranges were similar to Dragline Lake while the range in number

TABLE 3. Distribution of worker activity while thinning sample plots.

Study area	Activity distribution (%)					
	Felling	Releasing hang-ups	Brushing	Walking	Stopped	Other
Dragline Lake	40	38	5	16	1	0
Cowan	41	27	15	11	3	3
Hadashville - cutter	29	1	9	26	15	20
- helper	1	4	9	14	9	63*
Pine Falls	36	22	16	23	0	3
Black River Reserve	26	14	23	9	5	23

* includes the following activities:
selecting 16%
holding 26%
piling 21%

TABLE 4. Labour productivity summary for pre-commercial thinning by study area.

		Dragline Lake	Cowan	Hadashville	Pine Falls	Black River Reserve
Before thinning all standing stems (stems/ha)	Avg	13,068	36,005	29,233	13,699	20,140
	Min	7,470	18,000	6,000	8,400	10,500
	Max	36,360	70,816	76,414	20,889	28,778
Maximum height of slash on plot before thinning (cm)	Avg	33	30	41	43*	40*
	Min	0	5	0	40*	40*
	Max	80	60	150	50*	40*
Number of stems cut (stems/ha)	Avg	9,900	30,470	24,161	9,952	16,177
	Min	5,020	14,500	2,600	5,200	7,400
	Max	34,424	61,632	70,069	16,222	24,445
Thinning time ** (hours/ha)	Avg	19.5	19.5	66.4***	9.4	21.7
	Min	9.0	10.9	26.6***	5.5	12.4
	Max	34.6	29.2	114.8***	13.6	39.3

* Snow depth measured in lieu of slash heights

** Based on time to thin sample plot. Does not include rest breaks, tool maintenance, etc.

*** Sum of thinning times for cutter and helper.
Cutter's time averaged 33.1 hours (range 11.7 to 56.6)
Helper's time averaged 33.3 hours (range 14.8 to 58.2)

of stems cut was substantially greater. Future analysis will attempt to explain this variation.

The two person crew working in previously strip thinned (drum chopped) stands at Hadashville proved to be the most labor intensive operation, where as much as 114 hours per ha were required. The Hadashville production rates shown in Table 4 however, apply only to the area of the residual strip. Assuming residual strip width of 3 m and cut strip width of 2.5 m, only 55% of the area is actually thinned manually. On a total area basis where the area of the cut strip is included, productivity at the Hadashville site averaged 36.5 hours per ha and ranged from 14.6 to 63.1. These productivity rates refer to the sum of thinning times for each member of the two-person crew. The operational methods (i.e. two-person crew) and the different stand conditons preclude valid comparisons between productivity at the Hadashville area and areas 1 and 2. The Pine Falls and Black River areas have too few samples to allow meaningfull comparisons of productivity ranges.

Thinning times shown in Table 4 are based solely on productive times. Cutters were timed only while treating the plot and such time components as rest breaks or saw maintenance are not included.

FUTURE WORK

To date five thinning operations in juvenile stands have been examined to provide preliminary productivity estimates for pre-commercial thinning. The objective of this study is to develop equations to predict productivity (and therefore costs) for thinning in a variety of stands. The existing data base is limited in the range of stand conditions sampled (i.e., stand density, tree sizes, age, and species). Therefore additional field work is required to collect data in older and younger stands, and in particular black spruce stands, before reliable equations can be constructed that describe productivity over the full range of stands likely to be thinned in Manitoba. This data will be collected as additional thinning projects occur in the province.

Future work will also include collecting productivity information for manual release of spruce from hardwoods when such treatments are implemented in Manitoba. Although such operations are similar to pre-commercial thinning, thinning productivity estimates may not be applicable to release work, particularly in dense hardwood stands or in stands where large aspen trees occur.

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APPENDIX 1

List of common and botanical names for species cited.

Common Name	Botanical Name
Alder species	Alnus
Balsam fir	Abies balsamea
Black spruce	Picea mariana
Douglas fir	Pseudotsuga menziesii
Hazel	Corylus cornuta
Hemlock	Tsuga heterophylla
Jack pine	Pinus banksiana
Lodgepole pine	Pinus contorta
Tamarack	Larix laricina
Trembling aspen	Populus tremuloides
White birch	Betula papyrifera
Willow species	Salix

APPENDIX 2.

Detailed pre-treatment stand statistics.

DETAILED SUMMARY FOR AREA 1: DRAGLINE LAKE

NUMBER OF PLOTS AT THIS LOCATION: 17
SPH = stems per hectare
AVD = average dbh in cm

ATTRIBUTE		CONIFERS	HARDWOODS	DEAD	ALL SPECIES
TREES < 1.3 m	SPH	17	0	0	17
DBH 1-5 cm	SPH	6803	2113	14	931
	AVD	3.2	1.1	5.0	2.7
DBH 6-10 cm	SPH	3801	98	8	3907
	AVD	7.1	8.7	10.0	7.2
DBH > 10 cm	SPH	116	66	32	214
	AVD	12.7	11.3	16.6	12.9
DBH > 1 cm	SPH	10720	2277	54	13051
	AVD	4.7	1.7	12.6	4.2
ALL TREES	SPH	10737	2277	5	13068

DETAILED SUMMARY FOR AREA 2: COWAN

NUMBER OF PLOTS AT THIS LOCATION: 12
SPH = stems per hectare
AVD = average dbh in cm

ATTRIBUTE		CONIFERS	HARDWOODS	DEAD	ALL SPECIES
TREES < 1.3 m	SPH	5695	571	925	7191
DBH 1-5 cm	SPH	9716	2543	13368	25627
	AVD	3.3	1.3	1.8	2.3
DBH 6-10 cm	SPH	3128	10	11	3149
	AVD	6.9	7.0	6.0	6.9
DBH > 10 cm	SPH	38	0	0	38
	AVD	11.2	0.0	0.0	11.2
DBH > 1 cm	SPH	12882	2553	13379	28814
	AVD	4.2	1.3	1.8	2.8
ALL TREES	SPH	18577	3124	14304	36005

DETAILED SUMMARY FOR AREA 3: HADASHVILLE

NUMBER OF PLOTS AT THIS LOCATION: 21
SPH = stems per hectare
AVD = average dbh in cm

ATTRIBUTE		CONIFERS	HARDWOODS	DEAD	ALL SPECIES
TREES < 1.3 m	SPH	168	4739	630	5537
DBH 1-5 cm	SPH	4957	2029	9792	16778
	AVD	3.8	1.0	2.0	2.4
DBH 6-10 cm	SPH	5779	0	66	5845
	AVD	7.6	0.0	6.6	7.6
DBH > 10 cm	SPH	1063	0	10	1073
	AVD	12.1	0.0	18.0	12.1
DBH > 1 cm	SPH	11799	2029	9868	23696
	AVD	6.4	1.0	2.0	4.1
ALL TREES	SPH	11967	6768	10498	29233

DETAILED SUMMARY FOR AREA 4: PINE FALLS

NUMBER OF PLOTS AT THIS LOCATION: 5
SPH = stems per hectare
AVD = average dbh in cm

ATTRIBUTE		CONIFERS	HARDWOODS	DEAD	ALL SPECIES
TREES < 1.3 m	SPH	1609	1711	925	4245
DBH 1-5 cm	SPH	6723	1185	253	8161
	AVD	2.8	1.5	1.4	2.6
DBH 6-10 cm	SPH	1206	0	0	1206
	AVD	7.2	0.0	0.0	7.2
DBH > 10 cm	SPH	87	0	0	87
	AVD	11.9	0.0	0.0	11.9
DBH > 1 cm	SPH	8016	1185	253	9454
	AVD	3.6	1.5	1.4	3.3
ALL TREES	SPH	9625	2896	1178	13699

DETAILED SUMMARY FOR AREA 5: BLACK RIVER RESERVE

NUMBER OF PLOTS AT THIS LOCATION: 3
SPH = stems per hectare
AVD = average dbh in cm

ATTRIBUTE		CONIFERS	HARDWOODS	DEAD	ALL SPECIES
TREES < 1.3 m	SPH	4649	544	1026	6219
DBH 1-5 cm	SPH	8066	3860	834	12760
	AVD	2.1	1.3	1.2	1.8
DBH 6-10 cm	SPH	950	37	37	1024
	AVD	7.2	6.0	6.0	7.1
DBH > 10 cm	SPH	137	0	0	137
	AVD	12.0	0.0	0.0	12.0
DBH > 1 cm	SPH	9153	3897	871	13921
	AVD	2.8	1.4	1.4	2.3
ALL TREES	SPH	13802	4441	1897	20140